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Research article

A study of consumer behaviour towards food-waste in Ireland: Attitudes, quantities and global warming potentials

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ABSTRACT

This study aimed to investigate consumer behaviour towards food waste in Ireland by analysing their attitudes and quantities of food waste generated. Global warming potential of the food waste generated weekly is then assessed. A total of 2115 participants from all over the Republic of Ireland contributed to the survey (of which 2062 were included in this research). Using factor and cluster analysis, two clusters of consumers were formed based on their attitudes towards food waste, and it was found that 62.56% of the sample were 'uncaring' consumers and 37.44% were 'caring' consumers. The uncaring consumers consisted of more young males and were relatively unphased by food waste and take minimal precautions to reduce food waste at all stages of consumption. In contrast, caring consumers consisted of older and female consumers and were deeply disturbed by food waste, taking all precautions to reduce food waste at every stage of consumption. Regarding food waste quantities, uncaring consumers produced on average, 0.74 kg of food waste weekly, accounting for 2.74 kg of CO_2 equivalent in global warming potential, whereas caring consumers produced only half this amount. Our results thus suggest that consumers attitudes towards food waste directly impact the food waste quantities they generate and consequently the global warming effects. However, in Ireland all consumer groups can benefit from more information about food waste and our study contributes by providing information that can inform strategic communication campaigns at policy or organisational level, to educates consumers about food waste and how they are contributing to global warming.

1. Introduction

The Food and Agriculture Organisation (FAO) estimates that one-third of the edible parts of food produced for human consumption gets wasted globally, corresponding to 1.3 billion tons of food per year (FAO, 2011). Additionally, studies have shown that the average consumers annual household waste comprises of 40–60% food-waste (Farr–Wharton et al., 2014), this is particularly alarming when it is considered that two thirds of food-waste in Europe is avoidable (Broderick and Gibson, 2019). Moreover, when combining various studies claiming 30% of food is wasted at consumption (Williams, Wikström, Lö; fgren & Gustafsson, 2011), up to 10% of food is wasted at retail level (Buzby and Hyman, 2012) and taking into account food loss at production level, this indicates that potentially only an estimated 50% of food produced for humans is consumed (Wikströ; m, Williams, Verghese & Clune, 2014). In Ireland studies have shown that an estimated 30% of municipal waste in commercial settings, and 14% in households, is made up of food-waste, this means that this waste reaches landfill without being donated or diverted to higher use (Broderick and Gibson, 2019). Therefore, it is clear that decreasing food-waste is crucial for achieving a sustainable and resource efficient food chain as it takes a large amount of energy to produce food (Wikstrom et al., 2018).

The food sector is also known to be a large contributor to the worlds greenhouse gas emissions (GHG) producing over one third of all emissions globally, with beef and dairy causing the greatest environmental impact (Aschemann-Witzel et al., 2015; Williams & Wikströ; m, 2011). Foods detrimental effects on the environment is due to many factors, for example, gases from the production phase of food production such as nitrogen dioxide (N_2O) from fertiliser production and application are particularly harmful to the environment contaminating our air, water and soil qualities (Yeganeh, 2020; Carlsson-Kanyama et al., 2003, EPA, 2017; EPA, 2016; Ekstrom, Shanahan, 2003). Additionally, food production is also a major cause of species extinction as it involves about 70% of the global freshwater use thus straining our natural resources

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and harming biodiversity (FAO, 2019; Dyachenko et al., 2017; David, 2013). It is clear that when food is wasted, environmental degradation occurs to no avail and food decomposes in landfill adding further strain to our environment, thus, food-waste represents a huge environmental issue globally (Djekic, Miloradovic, Djekic and Tomasevic, 2018; Aschemann-Witzel, 2016).

Food-waste is also a global ethical issue, in wealthy countries food-waste is not an issue due to the low cost and abundance of food (Secondi et al., 2015), however, globally the level of hunger is on the rise with over 12.9% of the worlds population being undernourished and 9.1 million people dying from hunger annually (Marangon et al., 2015; FAO, 2011). Therefore, it has been noted by professionals that reducing the amount of food-waste is a key element in developing a sustainable food system (Marangon et al., 2015).

Considering the ethical and environmental concerns associated with food-waste, it is alarming that the effort made by organisations and governmental officials to communicate the issue of food-waste remains largely unsuccessful (Kim et al., 2020), and as a result food-waste is abundant in our everyday lives and remains largely uncontrolled (Farr-Wharton et al., 2014). For example, many studies have shown that consumers do have a bad conscious when wasting food (Kim et al., 2020; Djekic et al., 2018; Hebrok and Boks, 2017; McCarthy and Liu, 2017; Richter, 2017; Stefan et al., 2013), however, they still produce large amounts of food waste which can account for up to 2.46 kg CO2 a week per household (Djekic et al., 2018). These results are similar to that seen of the "ethical consumers" whereby their attitudes do not follow through to actions known as the attitude behaviour gap (Lee, 2019; Orzan et al., 2018). Therefore, it is important to recognise the factors effecting consumer behaviour towards food-waste including their attitudes, reasons for waste and waste quantities in order to decipher effective methods of food-waste prevention.

There are many habitual and behavioural reasons for food-waste amongst consumers (Roodhuyzen et al., 2017; Aschemann-Witzel et al., 2015). This can include visually suboptimal foods, misinformation amongst consumers surrounding labelling, lack of knowledge surrounding food storing conditions and poorly designed packaging which can result in 3–10% of the total product being wasted (Aschemann-Witzel et al., 2015; Martindale, 2014; Van-Boxstael et al., 2013, Devlieghere, Berkvens, Vermeulen and Uyttendaele, 2014; Wikström et al., 2014; Williams and Wikström, 2011; Marsh and Bugusu, 2007). Moreover, studies have shown that 60% of consumers do not see food-waste as an issue because it is biodegradable, thus wasting it is not an issue (Williams et al., 2011). This statement gains further merit when it is considered that studies have shown that a common cause for food-waste in households is a 'lack of plan", 'change of plan', 'buying too much' 'forgotten in storage' and 'do not want to eat leftovers' proving that food is not seen as a luxury, but an easily disposed product (Farr–Wharton et al., 2014; Williams et al., 2011).

Consumers sociodemographic factors can contribute heavily to their attitudes towards food-waste, consumer behaviour and waste generation. For example, studies have shown that young professionals (aged 16–35) are high food-wasters wasting over 30% of their food (Lyndhurst, Cox & Downing, 2006) and that those over 65 waste less food due to having experienced scarcity of food in the past (Hebrok and Boks, 2017). Culture can also cause for variance, for example when comparing US and Mexican households, Mexican households produce a higher volume of food-waste but this waste is comprised of non-edible foods such as bones, whereas US households waste is sub-optimal or wasted food (Thøgersen, 1993). Additionally, religion can cause discrepancies in consumers production of food-waste, for example in Islamic countries during Ramadan food-waste is often high (Aktas et al., 2018). Therefore, it is clear that sociodemographic factors can play a role in consumers behaviour towards food-waste.

In the literature, quantities and global warming potentials of food-waste have not been heavily focused on, this is partially due to the high cost associated with valid and precise measuring of these values (Parfitt et al., 2010). However, Djekic et al. (2018) suggests that measurements of food-waste quantity and global warming potentials can be extremely effective in communicating the issue of food-waste to consumers and organisations. The numerical data these values represent can easily resonate with consumers and allow for effective comparisons between populations and countries as a whole leading to valuable insights as to consumers true food-waste habits globally. The importance of food-waste quantity and global warming potential values is further stressed when it is considered that in order to reduce food-waste, an emphasis on the preventative measures of the waste hierarchy is needed, this includes; prevention, reduction at source and reuse (Diaz-Ruiz et al., 2018). Preventing food-waste cannot be done without firstly educating consumers about the issue and this can be done through integrated organisational and governmental campaigns which focus on the consumers perspective (Kim et al., 2020). Co-designed governmental food-waste campaigns have proven to be successful in the UK as food-waste decreased over 20% after the "Love Food, Hate Waste" campaign (Preifer et al., 2016).

In Ireland, it is estimated that over 1 million tonnes of food-waste is produced annually, 30% of which comes from households (Broderick and Gibson, 2018). In order to combat this the Irish government has set a target to reduce food-waste by 50% by 2030 (Government of Ireland, 2019). However, this target is overly ambitious when it is considered that Ireland only began segregating and treating their biodegradable waste in 2008 (EPA, 2006), and annually a large amount of biodegradable waste, including food-waste, is brought to landfill (EPA, 2019). For example, in 2017 over 206,000 tonnes of biodegradable waste was deposited in landfills across Ireland (EPA, 2019). At present, there has been a lack of research conducted in Ireland to assess consumer behaviour towards food-waste and how it prevails at an individual level across households. Additionally, limited food-waste campaigns have focused on consumers perspectives of food-waste (Secondi et al., 2015). Therefore, the aim of this study is to assess consumer behaviour towards food-waste in Ireland and analyse their attitudes, quantities of waste and the global warming potentials of this.

2. Materials and methods

2.1. Sample description

The present study was conducted from March to June in 2020 and a total of 2115 responses were obtained. However, after discarding unusable responses including consumers not living in Ireland, a total of 2062 useable responses were analysed.

The method of data collection used was online survey, and given that the target sample was consumers in Ireland, non-probability sampling was used to reach participants. Through convenience sampling, the survey was distributed through various social media channels. Additionally, responses were gathered using snowball sampling where the survey was shared by participants to other Irish consumers in order to give further diversity to the sample which was out of the authors immediate reach.

2.2. Questionnaire design

The survey questionnaire was designed in-line with previously validated questionnaires (Djekic et al., 2019; Richter, 2017) which were also used for conducting similar food-waste studies. Appropriate modifications were made to the questionnaire to fit the popular habits and traditions of consumers in Ireland.

The questionnaire was divided into four sections. Firstly, a section was presented which gathered demographic characteristics of the participants. The second section assessed consumers attitudes towards food-waste, this was done by presenting statements relating to food-waste across 5 different perspective dimensions (ethical, environmental, purchasing behaviour, preparation and influence of expiry date) and

measuring participants level of agreement with these statements using a 5-point Likert scale. To gain insights into the respondent's food-waste habits, the third section examined participants most prevalent reason for wasting food by using a multiple-choice question. Finally, a section was presented which analysed participants food-waste quantities, within this section 15 different food items were presented, and participants were asked to indicate how many handfuls they waste of this item weekly ranging from 0 to ≥5. The quantity measurement of handfuls was used to give participants ease rather than asking for specific quantities in grams (g) or millilitres (ml). Additionally, previous food-waste studies have used this methods and it is said that 1 handful equates to an estimated 200 g or 200 ml (Djekic et al., 2019). Alternatively, participants could indicate that they have not wasted food in the last week, or selected that they do not consume food in certain categories such as dairy and meat. From this section, both estimated quantity of food-waste weekly and the global warming potential could be deciphered.

2.3. Data analysis

2.3.1. Sample profile

Table 1 presents 6 of the demographic characteristics of the sample. 80.02% of the respondents were females, 26.48% were between the ages of 21 and 34, 57.08% were from town, 27.40% had an annual income between €15,000 - €34,999 euros, 54.07% of the respondents had a university education, and 51.36% were married with children.

Table 1
Sample demographics (N = 2062).

Characteristic	Category	Respondents	Percentage
Gender	Female	1650	80.02%
	Male	402	19.50%
	Other	2	0.10%
	Prefer not to say	8	0.39%
Age	20 or younger	111	4.38%
	21–34	546	26.48%
	35–44	447	21.68%
	45–54	585	28.37
	55–64	281	13.63%
	65 or older	49	2.38%
Education	Primary Education	18	0.87%
	High School or equivalent	467	22.65%
	College/University Qualification	1115	54.07%
	Postgraduate Qualification	413	20.03%
	Other	49	2.38%
Marital Status	Unmarried	702	34.04%
	Married without children	118	5.72%
	Married with children	1059	51.36%
	Other	183	8.87%
	Unemployed	290	14.06
Income	≤ €15,000	235	11.40
	€15,000 - €34,999	565	27.40%
	€35,000 - €54,999	467	22.65%
	€55,000 - €74,999	265	12.85%
	≥ €75,000	240	11.64%
Residence	Countryside	569	27.59%
	Town	1177	57.08%
	City	316	15.32%

2.3.2. Food-waste quantities calculation

$$QFW_i = \sum_{i=1}^{n} \frac{TH_i \times 200}{1000} \quad [kg/L]$$

TH = Total Handfuls

The weekly quantities of food-waste (QFW) for each participant was obtained by multiplying the respondents recorded weekly disposed handfuls of waste for each item by 200 g/ml (Equation 1). The average QFW per item and for consumers in total was then calculated.

Equation 1. Quantities of Food-Waste equation.

$$\%\ \text{Zero wasters} = \frac{NW}{n} + \frac{TH0_i}{n} \left[\underset{*}{\frac{ND}{n}} \right] \left[\underset{**}{\frac{NM}{n}} \right]$$

NW = Non Wasters
TH0 = Total 0 Handfuls
ND = Don't eat dairy
NM = Don't eat meat
** = for dairy items*
*** = for meat items*

Additionally, in order for these results to be truly representative of the sample populations waste habits, the number of 0 wasters for each food item was also calculated. This was done by finding the percent of respondents who had not wasted food in the last week, had answered 0 handfuls wasted for the item and taking other dietary requirements into consideration (Equation 2).

Equation 2. Zero wasters equation.

2.3.3. Global warming potential calculation

$$GWP_i = \sum_{i=1}^{n} QFW_i \times C \quad [kg\ CO_2]$$

QFW = Quantity of food-waste
C = CO_2-emission equivalent

The weekly GWP of food-waste was obtained by multiplying the QFW per item by the CO_2 emission equivalent of the food item. This process is summarised by the equation below (Equation 3).

Equation 3. Global Warming Potential equation.

The values used for the CO_2 emission equivalent of food items were obtained from Clune et al. (2017) in which estimates of the CO_2 equivalents per kilogram (kg) for various different fresh food items are deciphered by synthesising previous key works and analysing estimates of CO_2 equivalents available on databases.

2.3.4. Factor analysis

Factor analysis was undertaken in order to condense the number of variables to be analysed within the dataset for effective analysis to take place, and interrelations amongst variables in the dataset to be identified. Based on the results of a scree plot and eigenvalue variance, six factors were chosen in the analysis which were significant. The six factors could be better interpreted and labelled by analysing the rotated component matrix and assessing correspondence between factors and variables which had a fair level of greater than 0.3 (Table 2). These factors explain 55.11% of total variance amongst the sample in the dataset which can be ranked as good as it is over 50% (Richter, 2017). Furthermore, when considering the Kaiser-Meyer-Olkin value of 0.782 and Bartlett's test of sphericity being highly significant showing a high correlation between variables, the factor analysis conducted can be seen to be very reasonable.

Given that all factors touch on variables from each dimension of the survey, this gives significant merit to assess the dataset based off of these dimensions including; Ethical, environmental, purchasing, preparation and influence of expiry date. This was confirmed by the Cronbach Alpha test, this is used to test consistency within variables and in the present study was shown to have a value of 0.59. Although it is suggested that a value of 0.7 or greater for Cronbach's Alpha is needed to be sufficient, additional studies suggest that factors which consist of more than 1

Table 2
Summary of factors and their items.

Factor and Items	Factor Loading
1: Uncaring (Influence of Expiry Date & Environmental)	
Often, I forget to eat products before they spoil	0.522
I do not think of the environmental impact when wasting food	0.642
2: Ethically Conscious (Ethical)	
I have a bad conscious when I waste food	0.615
I feel guilty when I waste food because others don't have enough to eat	0.614
3: Expiration Conscious (Influence of Expiry Date)	
I think it is better to throw away food than to risk eating unsafe food and getting sick	0.566
I take care not to consume food after the expiration date	0.549
4: Waste Conscious (Environmental & Preparation)	
Food packaging is a bigger environmental issue than food-waste	0.464
I eat food waste leftovers the next day	0.471
5: Wasteful **Consumers (Environmental)**	
Food-waste is not an environmental problem because its biodegradable	0.473
I do not think of the environmental impact when wasting food	0.372
6: Remorseful **Consumers (Purchasing & Preparation)**	
I am worried about the cost of food that I throw away	0.349
I always prepare more food than I need	0.339
Kaiser- Meyer Olkin (KMO) = 0.782; Explained Variance = 55.11% Bartlett-Test on spherity = 10418.672; Significance = 0.000	

variable are accepted if the value is greater than 0.5 (Richter, 2017).

2.3.5. Cluster analysis

In order to identify segments of consumers in Ireland with similar beliefs and attitude patterns they attach to food-waste, a cluster analysis was used to group these consumers. This method allowed the researchers to analyse the difference between different types of consumers in Ireland and summarise the objectives of this study across these groups giving results representative of all consumers in Ireland.

Using a 2-step cluster technique, 2 clusters were formed based on participants attitudes towards food-waste to give 2 separate groups which were labelled "Caring" and "Uncaring" consumers.

The "Uncaring" cluster consisted of 1290 respondents which accounted for 62.56% of the total sample and the "Caring" cluster consisted of 772 respondents, which accounted for 37.44% of the total sample. Cluster demographics presented in Table 3 show that the "Uncaring" cluster had higher percentage of males; young consumers under the age of 35; and unmarried consumers. The "Caring" cluster had a higher percentages of females; older consumers over the age of 55; and married consumers. These results are in-line with previous studies conducted on food-waste where it has also been found that young males are more likely to be in uncaring clusters (Djekic et al., 2019; Richter, 2017; Di Talia, Simeone, Scarpato, 2019), and that older consumers are more caring towards food-waste (Hebrok and Boks, 2017).

3. Results and discussion

3.1. Attitudes towards food-waste

Table 4 presents the summary of consumer attitudes towards food waste of the two clusters and highlights that the "Uncaring" cluster does not have strong feelings surrounding the ethics of food-waste, they do feel guilty when wasting food (Mean = 3.91) and that there is food they waste which could be avoided (3.58). While "Caring" cluster agreed strongly that they have a bad conscious when wasting food (4.75) and acknowledge guilt when wasting food because others do not have enough to eat (4.3). Similar results are presented by McCarthy and Liu (2017) and Richter, 2017 where it was found consumers feel negative emotions such as guilt when discarding food.

Furthermore, both clusters were aware of the environmental issues surrounding food-waste. However, those in the "Uncaring" cluster felt less strongly about this and strongly agreed that food packaging is a

Table 3
Cluster demographics.

		Cluster 1 – Uncaring (n = 1290)		Cluster 2 – Caring (n = 772)	
Characteristic	Category	Respondents	Percent in Cluster (%)	Respondents	Percent in Cluster (%)
Gender	Female	990	76.74	660	85.49
	Male	293	22.71	109	14.12
	Other	1	0.08	1	0.13
	Prefer not to say	6	0.47	2	0.26
Age	20 or younger	87	6.74	24	3.11
	21–34	364	28.22	182	23.58
	35–44	264	20.47	183	23.70
	45–54	372	28.84	213	27.59
	55–64	161	12.48	120	15.54
	65 or older	42	3.26	50	6.48
Education	Primary Education	14	1.09	4	0.52
	High School or equivalent	310	24.03	157	20.34
	College/University Qualification	699	54.19	416	53.89
	Postgraduate Qualification	237	18.37	176	22.80
	Other	30	2.33	19	2.46
Marital Status	Unmarried	470	36.43	232	30.05
	Married without children	63	4.88	55	7.12
	Married with children	657	50.93	402	52.07
	Other	100	7.75	83	10.75
Income	Unemployed	179	13.88	111	14.38
	≤ €15,000	152	11.78	83	10.75
	€15,000 - €34,999	349	27.05	216	27.98
	€35,000 - €54,999	283	21.94	184	23.83
	€55,000 - €74,999	166	12.87	99	12.82
	≥ €75,000	161	12.48	79	10.23
Residence	Countryside	348	26.98	221	28.63
	Town	764	59.22	413	53.50
	City	178	13.80	138	17.88

Table 4
Consumer attitudes summary.

Food-Waste Dimension	Statement	Cluster 1 - Uncaring (n = 1290)		Cluster 2 - Caring (n = 772)		Un-clustered Total (n = 2062)	
		Mean	STDEV	Mean	STDEV	Mean	STDEV
Ethical	I have a bad conscious when I waste food	3.91	1.09	4.75	0.74	4.22	1.06
	I feel guilty when I waste food because others don't have enough to eat	3.58	1.20	4.30	0.99	3.85	1.18
	I try to avoid wasting food but I often catch myself doing so	3.55	1.08	2.89	1.31	3.30	1.22
	There is often food I waste which could have been avoided	3.68	1.23	2.82	1.36	3.36	1.35
Environmental	I do not think of the environmental impact when wasting food	2.87	1.30	1.69	1.13	2.43	1.36
	Food-waste is not an environmental problem because its biodegradable	2.63	1.14	1.62	0.96	2.25	1.18
	Food packaging is a bigger environmental issue than food waste	4.09	1.13	3.75	1.18	3.96	1.16
	I feel disturbed by the amount of food being wasted since it takes a lot of resources to grow, process, package and transport food.	3.71	1.07	4.67	0.76	4.07	1.07
Purchasing Behaviour	I only buy products which are on my shopping list	2.42	1.19	3.30	1.17	2.75	1.26
	I plan meals for several days to purchase more efficiently	2.80	1.29	3.78	1.17	3.17	1.33
	When I see a "Sale" in stores I often buy more than I intended	3.45	1.25	2.92	1.27	3.25	1.28
	I never buy food I already have at home (in my fridge)	2.83	1.21	3.57	1.16	3.11	1.24
	I am worried about the cost of food that I throw away	3.26	1.13	3.68	1.21	3.41	1.18
Food Preparation	During food preparation I take care to use everything possible	2.59	1.20	3.74	1.13	3.02	1.30
	If something remains after cooking, I freeze it for a later use	3.39	1.32	4.55	0.79	3.82	1.28
	I eat food leftovers the next day	3.86	1.17	4.73	0.59	4.18	1.08
	I always prepare more food than I need	3.11	1.17	2.81	1.26	3.00	1.21
Influence of Expiry Date	I evaluate food to be thrown by its appearance/smell	3.99	1.10	3.88	1.23	3.95	1.15
	I take care not to consume food after the expiration date	3.49	1.36	2.45	1.36	3.10	1.45
	I think it is better to throw away food than to risk eating unsafe food and getting sick	4.07	1.10	3.33	1.24	3.80	1.21
	Often, I forget to eat products before they spoil	3.62	1.13	2.43	1.18	3.17	1.29
	It feels good to clean out the fridge and get rid of old food	3.88	1.07	3.00	1.33	3.55	1.25

bigger issue than food-waste (4.09) and did not feel strongly that food-waste disturbed them (3.71). In contrast, the "Caring" cluster was unsure or moderately agreed that food packaging is a bigger environmental issue than food-waste (3.75) and felt strongly that food-waste disturbed them (4.67). These finding are similar to that of Williams et al. (2011) where it was estimated that 75%–90% agreeing packaging is a far greater environmental issue than food-waste.

It was found that "Uncaring" cluster do not make shopping lists (2.42) or plan meals before purchasing (2.8) and often purchase items they have at home in their fridge (2.83) as a result. This was different to that of the "Caring" cluster who agree that they plan their purchasing effectively in order to minimise waste (3.30 and 3.78). However, both the "Uncaring" and "Caring" groups were concerned about the cost of food that is thrown away (3.36 and 3.68). Although this contrasts what is said about food abundance and value loss across third world countries in the literature (Secondi et al., 2015), this finding suggests that Irish consumers want to get the most out of their purchases.

Following on, it is clear for both clusters that they have some level of waste minimising behaviours such as freezing food and eating leftovers. This confirms the findings in other European studies in Serbia and Germany where it is found consumers practice this to reduce waste (Djekic et al., 2019; Richter, 2017). However, those in the "Uncaring" cluster disagreed that they take care to use everything in food preparation (2.59) and those in the "Caring" cluster only moderately agreed (3.74) which contradict the findings of Djekic et al. (2019) and Richter, 2017. These differences could suggest that there is cultural differences between Ireland and these countries which have led to a lack of care regarding food-waste at preparation stages in Ireland. This corroborates the research of Fami et al. (2018) where it is suggested that food-waste is a social issue which needs to be changed throughout the consumption chain ranging from purchase planning to actual food consumption.

Finally, both the "Uncaring" and "Caring" cluster it is agreed that

Table 5
Quantity of food-waste.

Food Item	Cluster 1 – Uncaring		Cluster 2 – Caring		Un-clustered - Total	
	Q/person (kg/L)	Zero Wasters (%)	Q/person (kg/L)	Zero Wasters (%)	Q/person (kg/L)	Zero Wasters (%)
Vegetables	0.13	35	0.08	61	0.11	44.52
Fruit	0.11	23	0.06	68	0.09	54.03
Bread	0.08	38	0.04	81	0.06	68.14
Rice	0.04	59	0.02	91	0.03	85.31
Potatoes	0.08	38	0.04	81	0.03	68.57
Beans	0.02	68	0.01	84	0.01	93.26
Milk	0.04	54	0.02	92	0.03	84.63
Cheese	0.04	55	0.02	91	0.03	84.63
Yogurt	0.05	48	0.02	89	0.04	79.39
Soymilk	0.00	75	0.00	99	0.00	98.25
Beef	0.04	51	0.02	90	0.04	82.20
Lamb	0.01	69	0.00	99	0.01	97.28
Pork	0.02	61	0.01	94	0.02	90.54
Chicken	0.07	40	0.03	87	0.05	74.49
Fish	0.02	64	0.01	96	0.01	97.73
Total	0.74		0.37		0.60	

Table 6
GWP results.

Food Item	Cluster 1 – Uncaring GWP (CO2 eq/kg)	Cluster 2 – Caring GWP (CO2 eq/kg)	Unclustered - Total GWP (CO2 eq/kg)
Vegetables	0.06	0.04	0.05
Fruit	0.05	0.03	0.05
Bread	0.04	0.02	0.03
Rice	0.10	0.05	0.08
Potatoes	0.02	0.01	0.01
Beans	0.01	0.00	0.01
Milk	0.05	0.02	0.04
Cheese	0.34	0.16	0.27
Yogurt	0.07	0.03	0.06
Soy Milk	0.00	0.00	0.00
Beef	1.29	0.57	1.02
Lamb	0.20	0.07	0.15
Pork	0.14	0.07	0.11
Chicken	0.27	0.11	0.21
Fish	0.08	0.03	0.06
Total	2.74	1.22	2.16

they do evaluate food to be thrown away by its appearance or smell (3.99 and 3.88). However, the "Uncaring" cluster would not consume past expiry date (3.49) due to fear of eating unsafe food and falling ill (4.07). In contrast, those in the "Caring" cluster disagreed that they take care not to consume food after expiry date (2.45) and disagreed that they forget to eat products before they spoil (2.43). These findings echoes the work done by Visschers et al. (2016) where it was found that those who overvalue the meaning of expiry dates produce more food-waste.

3.2. Reasons for food-waste

Similar to results seen by Van-Boxtael et al. (2013), overall the main reason for food-waste in Ireland was seen to be: expired food (33%); rotten taste or smell (27%); and waste from meals (18%). However, when analysing reasons for food-waste across each cluster differences can be seen. With 42% of the uncaring cluster wasting food due to expiration as against 19% of caring cluster wasting the same reason. For Uncaring cluster 19% food waste was due to rotten taste/smell, while it caused 39% of caring customers to waste food. Waste from meals was the reason for 21% of uncaring cluster and 14% of caring cluster. 11% of uncaring cluster generated food waste from food preparation while 22% of caring cluster did the same. Finally, appearance of food caused food waste in 7% of uncaring cluster and 6% of caring cluster. Overall it was observed that the "Uncaring" clusters reason for food waste are far more avoidable than that of the "Caring" cluster. Avoidable food-waste is food that could at some point have been eaten, whereas unavoidable food-waste includes elements such as trimmings and bones (Quested et al., 2013).

3.3. Quantities of food-waste

When considering the total sample, it can be seen that consumers in Ireland on average waste 0.6 kg of food-waste weekly with vegetables (0.11 kg), fruit (0.09 kg) and bread (0.06 kg) being the items with the largest amount of waste weekly (Table 5). These results are in line with previous European studies completed regarding estimated quantities of food-waste where it has been found that individuals in households produce over 0.5 kg of food-waste weekly with fresh foods and breads being the largest quantities wasted (Djekic et al., 2019).

Moreover, when analysing QFW for each cluster, differences can be seen. Firstly, the total QFW weekly for the "Uncaring" cluster (0.74 kg) is exactly twice that of the "Caring" cluster (0.37 kg). Secondly, the "Uncaring" cluster has significantly less zero wasters across all food items than that of the "Caring" cluster. Therefore, it can be argued that consumers food-waste attitudes are directly related to their food-waste quantities.

3.4. Global warming potentials of food-waste

The weekly GWP values found for each cluster and across the sample as a whole are presented in Table 6. Overall, across the total sample, it was found that dairy and meat items have high GWP values with beef (1.023 kg CO_2), cheese (0.272 kg CO_2) and chicken (0.210 kg CO_2) being the highest. Moreover, when combining the GWP for all food items across the whole sample, it was found that the average consumer in Ireland creates 2.161 kg CO_2 equivalent in food-waste weekly. This is an extremely alarming statistic, especially when it is considered that Ireland has a population of over 4.9 million, all of which will be consumers one day, and if each consumer produces 2.161 kg CO_2 weekly due to food-waste this accounts for over 10.5 million kg of CO_2 emissions weekly for all consumers.

When further analysing the GWP produced across each cluster, due to the difference in QFW values, significant differences were seen. It was found that the "Uncaring" cluster produces over twice the amount of CO_2 equivalent emissions weekly (2.738 kg CO_2) than those in the "Caring" cluster (1.216 kg CO_2).

4. Conclusion

Consumers in Ireland can be broadly divided into 2 groups, Caring consumers (37.44%) or Uncaring consumers (62.56%). While both groups feel guilty when wasting food, and worry about the cost of food which is thrown away, they are also very different. Uncaring consumers are aware of the environmental effects of food-waste and feel guilty when wasting food, yet are unphased by its unethical elements, they overvalue the expiry date which results in 0.74 kg of food-waste weekly giving a GWP of 2.738 kg CO_2. In contrast, Caring consumers are aware the environmental and ethical issues surrounding food-waste and take care to reduce food-waste where possible producing only 0.37 kg of food-waste weekly giving a GWP of 1.216 kg CO_2. Although these QFW and GWP statistics are alarming, these values have huge potential to change if those "Uncaring" consumers are re-educated regarding the issue of food waste.

It is clear that the present study provides a large amount of information and data that has the ability to resonate with consumers in Ireland regarding food waste. This study is particularly valuable as it holds the baseline of data needed regarding consumer behaviour towards food-waste, the quantities of waste generated and its global warming potential in Ireland. This data can be used to inform strategic communication campaigns at which can aid in educating consumers regarding the issue of food-waste. This could result in a range of benefits such as reducing waste costs, protecting our environment and creating a more sustainable food system.

Declaration of competing interest

The authors declare no conflict of interest.

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